Space Weather Technical Forecast

Issued on Thursday, 27 April 2023 at 13:23 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of G1/G2 decreasing through period. Increased Chance R1/R2 throughout. Electron flux at GEO expected to recover through UTC weekend.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity rose to Moderate over the past 24 hours, with X-ray activity recorded at GOES16 peaking with an M1.8 at 27/1113UTC from AR3288 south-centre disc, otherwise seeing occasional C-class activity. There was no concurrent dimming or obvious CME generated, however this aspect will be monitored.

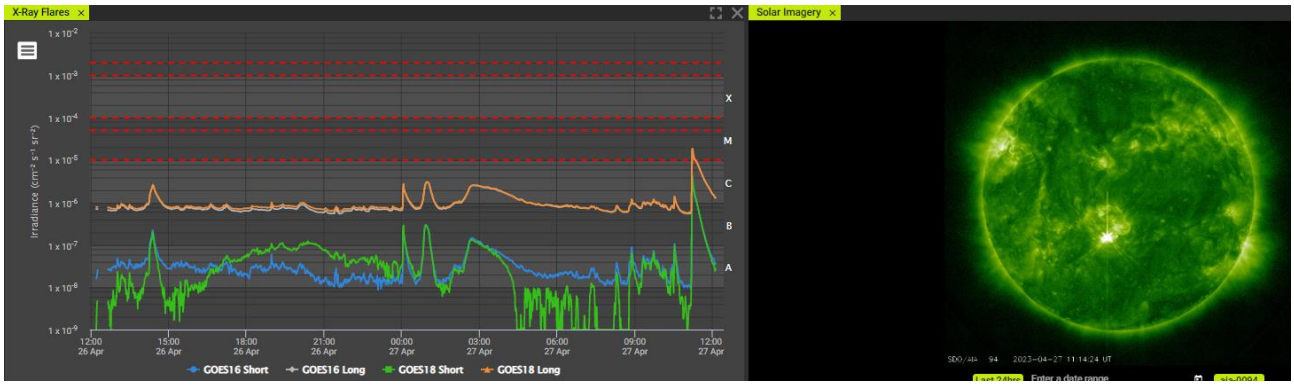

Figure 0: GOES16 and 18 X-ray traces and AIA094 imagery of the peak flare of the period, an M1.8 from AR3288.

Flare activity was roughly split between two of the seven active regions on the disc: AR3288 and AR3289. AR3288 took the form of a growing Beta-Gamma-Delta Dsi in the south-central disc, with its intermediate spots appearing and increasing in size, eventually forming a Mt Wilson Delta through the UTC morning. AR3289 appeared to be more stable in terms of growth trends, manifesting as a Beta-Gamma Dsi in the northeast, although the narrow viewing angle may be concealing detail.

Other noteworthy flares of the 24 hours were a C3.0 from AR3289 at 27/0058UTC, with this flare perhaps providing the impetus for one of the most significant events on the disc in the period around an hour later - a large filament eruption to its immediate southwest. A provisional analysis has been conducted of this event, and it appears to most likely to lag the Earth in the track of its orbit to no effect. Further analysis will be attempted should STEREO A COR2 for the period become available.

A number of possible Coronal Mass Ejections (CMEs) have been seen leaving the northeastern limb in the past 36 hours or so - while some are perhaps attributable to the vicinity of AR3289, there appears to be a source further north and east that may reveal itself here into the coming UTC weekend.

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Of the remainder of the seven sunspot regions on the disc, only those just east of the meridian showed any growth - the aforementioned AR3288, but also AR3286 and AR3291, which both became more congested bipolar regions in the period.

Solar Wind / Geomagnetic Activity: The solar wind, as observed by ACE/DSCOVR at L1, showed the onset of a fast wind regime in the 24 hours, beginning around 26/1800UTC, likely to be that emanating from CH96/-, with the phi angle accordingly negative (towards the Sun) through the 24 hours.

The solar wind speed rose from Elevated levels near 525km/s to peak at Strong near 625km/s. The solar wind density was Slightly Elevated in low double figures ppcc prior to the coronal hole's onset, but has since fallen to more typical single figures ppcc. The IMF also rose to a Slightly Elevated peak of 10nT shortly before 26/1800UTC, since falling to Background levels with a steady tendency. The north-south component displayed a changeable character, ranging between +9 and -8nT, with no protracted aligned or anti-aligned periods observed.

The net effect of the above solar wind measures was for mainly Unsettled to Active activity, with a provisional peak of Kp 4+ in the 00-03 and 03-06UTC intervals.

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV) as measured at GOES16, has been at Background levels throughout.

High energy electron flux (greater than 2MeV) as measured at GOES16, saw an attenuation of its diurnal trend in the period, falling from early High flux and a peak of 4560pfu 26/1510UTC to Normal Background. The associated 24-hour electron fluence rose sharply before plateauing in the period, to record 1.07e8 integrated pfu at 27/0001UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is Likely to remain Low, with a now increased Chance of reaching Moderate levels. No significant regions leave and no returning regions are due to alter this forecast, leading to a flat trend. Possibly complicating this, CME activity from the northeastern limb may yet reveal a newly-developed region here that may factor into probabilities later this week.

Solar Wind / Geomagnetic Activity: Up to three CMEs feature in the forecast. Firstly, a filament eruption on 24 April produced a CME which may soon deliver a glancing blow at Earth, although confidence in this occurring at all is now reduced. Secondly and thirdly, further filament eruptions on 25-26 April gave CMEs which are considered most likely to miss, but there is a very low risk of a glancing blows during Days 2 and 3 (28 and 29 April).

The coronal hole-driven forecast is otherwise for solar wind speeds currently at Strong levels from equatorial CH96/- to continue for much of the period, although reducing in strength and perhaps fading entirely later in the UTC weekend.

All considered, Day 1 geomagnetic activity is expected to be Unsettled or Active, with a Chance of G1/Minor Storm conditions and perhaps still a surviving Slight Chance of a G2/Moderate Storm, should the CME arrive soon and with its Bz strongly anti-aligned with Earth's field. Activity is then likely to generally wane through Days 2, 3 and 4, although the risk of further CME glancing blows on Day 2 and 3 may prolong a Slight Chance of G1 intervals.

Energetic Particles / Solar Radiation: No solar radiation storms are expected, with a very slightly increasing chance in the four days due to typical westward advance of all contributing solar regions. The recent Moderate class X-ray flare has very slightly increased the chances of a solar

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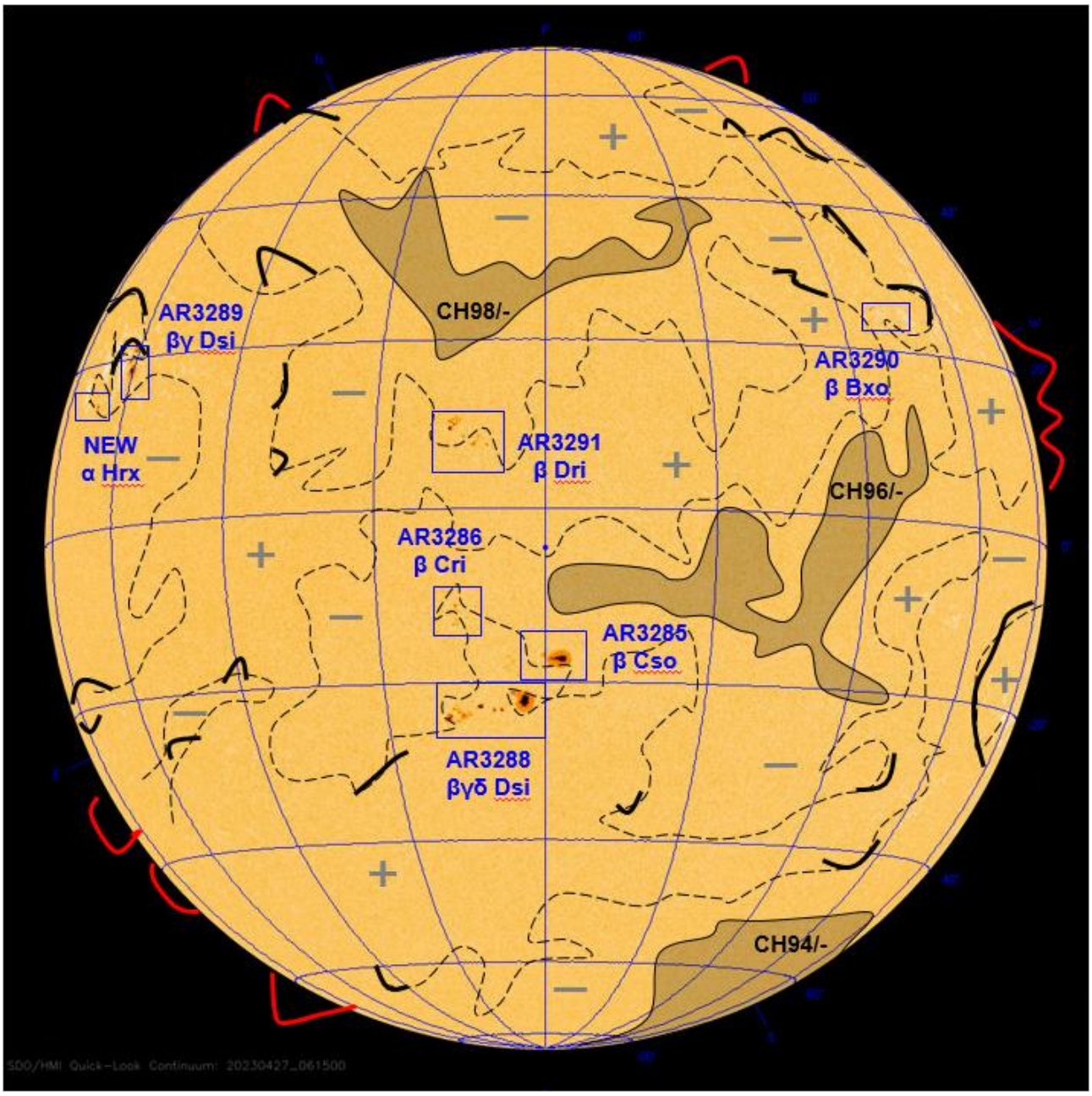
radiation storm in the coming 12 hours or so, although this remains unlikely.

High energy (greater than 2MeV) electron flux suppression at GEO is likely to prove temporary, with a recovery anticipated into the coming UTC weekend given the incumbent CH96/- fast wind. The degree to which this occurs is lower confidence due to the presence of up to three transients over the persistence forecast - which is otherwise considered good guidance.

Figure 1. Solar Analysis Valid 27/0615UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

Up to three CMEs may feature in the forecast.

The first of these arose from a filament eruption that occurred near south-centre disc starting around 24/1300 UTC. The CME was observed in coronagraph imagery heading generally south, but some Earth-directed component is possible, with any glance either arriving soon within day one (Thursday 27 April) or else perhaps more likely a miss. Confidence in any arising activity is now lower for the feature being longer in transit. ACE EPAM LEMS does not currently show any evidence of any impending enhancement, and STEREO A MAG data further east at 1AU appears unremarkable.

Secondly and thirdly, two further filament eruptions from the southwest quadrant were observed to produce CMEs late on 25 and early on 26 April. These appear mostly directed ahead of and below Earth's orbit, and are considered most likely to miss, but there is a very low risk of glancing blows during Days 2 and 3 (Friday 28 and Saturday 29 April).

The persistence and coronal hole forecast is more clear-cut. Solar wind speeds currently at Strong levels with the arrival of the HSS associated with equatorial CH96/-. Current observed speeds are broadly consistent with this feature on the previous rotation, however there remains in theory a risk of the potential arrival of the CME from 24 April. This could combine with the HSS to increase the geomagnetic response. The HSS from CH96/- is expected to continue at affect Earth into Days 2 and 3 (28 and 29 April), perhaps with some weakening of the winds during Day 4 by the end of the UTC weekend.

All considered, Day 1 geomagnetic activity is expected to be Unsettled or Active, with a Chance of G1/Minor Storm conditions and perhaps still a surviving Slight Chance of a G2/Moderate Storm, should the CME arrive soon and with its Bz strongly anti-aligned with Earth's field. Activity is then likely to generally wane through Days 2, 3 and 4, although the risk of further CME glancing blows on Day 2 and 3 may prolong a Slight Chance of G1 intervals.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	50	20	10	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

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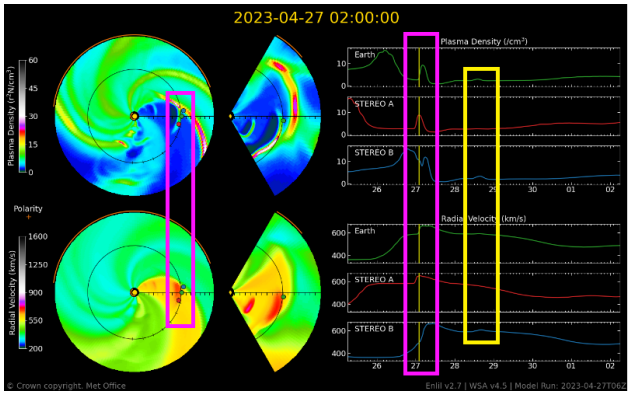
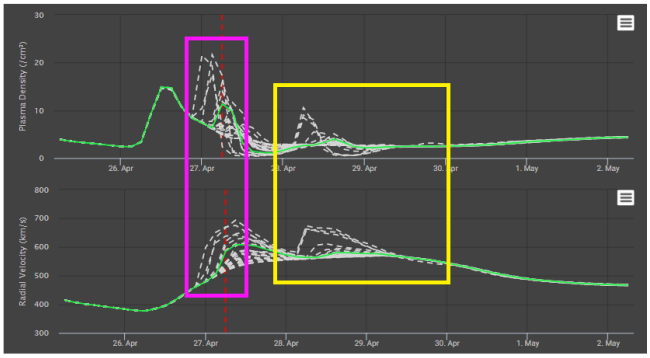
Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
24/1900	Partial	Filament	SW	700km/s	Overdue	Arriving soon else most likely a miss. Glancing.

Figure 2: Latest MOSWOC Enlil and ensemble, showing overdue 24 April filament eruption boxed magenta, with lower confidence subsequent CMEs shown in yellow. Enlil is handling the current fast wind from Ch96/- well, with solar windspeeds closely matching the suggested 600km/s. The duration of this feature is also considered good guidance, easing later in the coming UTC weekend.





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Radio Blackouts - X-Ray Flares:

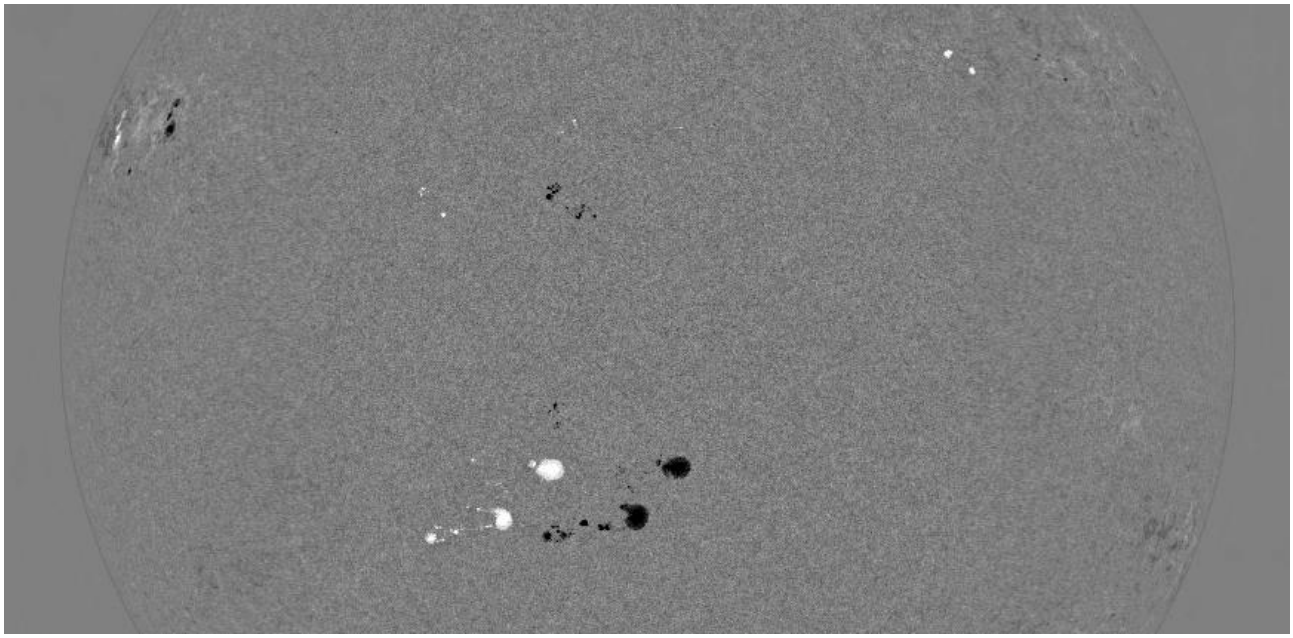
The Mt Wilson delta spot that has appeared in AR3288 in the period appears to have recently lived up to its billing and borne fruit in delivering an impulsive M1.8 flare at 27/1113UTC. Relative to recent guidance, developments in AR3288 have helped drive an increase to the daily flare risks, with a Chance of M-class activity now maintained throughout, with the most likely sources of activity being AR3288 and perhaps also AR3289.

There are currently seven sunspot regions on the visible disc, with AR3292 recently attaining a number near the northeastern limb.

Only the relatively simple AR3290 is expected to leave the Earth-facing side in the period. In terms of returning Carringtons and persistent regions on the far side, there are not any due, however there appears to be a source for CME activity narrowly behind and perhaps on the northeastern limb at present, which may hint at a new arrival - to be determined through the next couple of days.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**R1-R2 M Class**	Yes	30	30	30	30
Very Active	**R3 to R5 X Class**	No	1	1	1	1

Figure 3: 24-hour difference imagery in HMIIF sunspot region footprints – white valid 26/0845UTC, black 27/0845UTC. Note the three sunspot regions moving from around 20 East to 10 East all displayed growth, with the remainder more similar between timesteps. Image processing using Helioviewer.org.



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Solar Radiation Storms - (High Energy Protons):

No solar radiation storms are expected, with a very slightly increasing chance in the four days due to typical westward advance of all contributing solar regions. The recent Moderate class X-ray flare has very slightly increased the chances of a solar radiation storm in the coming 12 hours or so, although this remains unlikely.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	2	5	5
Very Active	**≥ S3 ***	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

High Energy Electrons Event (≥ 2MeV):

High energy (greater than 2MeV) electron flux saw its diurnal oscillation strongly attenuated at GEO in the period due to overnight Active Kp intervals from the current CH96/- fast wind. This apparent suppression of counts is likely to prove temporary, as already appears to be the case with a current rebound being observed. A more lasting recovery is anticipated into the coming UTC weekend. The degree to which this occurs is lower confidence due to the presence of up to three transients over the persistence forecast - which is otherwise considered good guidance.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	Yes	100	40	60	70
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	5	10

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Figure 4: Past 24 hours in GOES16 high energy electron flux, showing a decline at GEO as the fast wind from CH96/- established over the same interval.

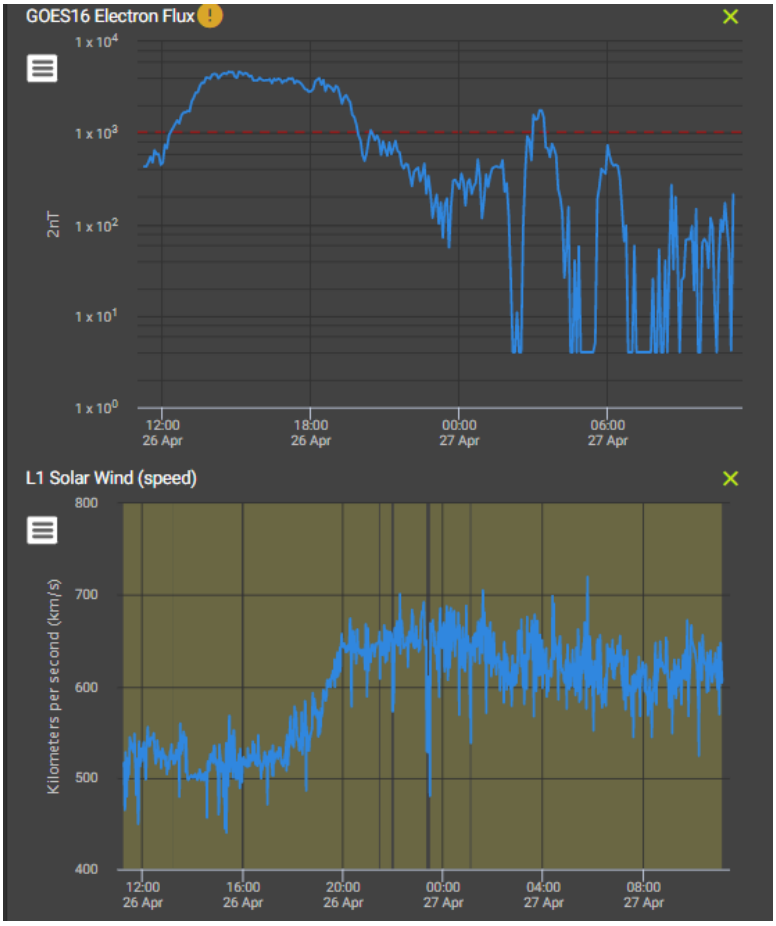
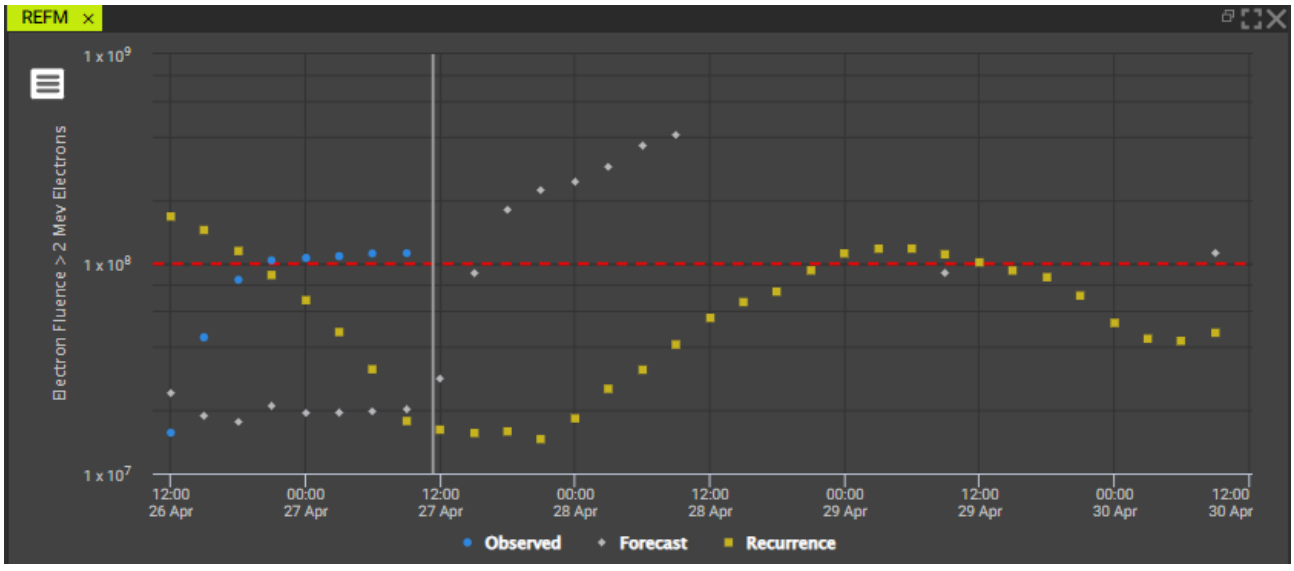


Figure 5: Latest MOSWOC REFM, showing observed 24-hour fluence as having risen to a plateau in recent hours. The persistence trend (yellow) is considered good guidance in the absence of significant intervening CMEs (which is considered possible).



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